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13. ABSTRACT (Maximum 200 words) To counteract the effects of dispersion in the transmission of signals in optical fibers, it is desirable to use nonlinear wave pulses in the form of solitary waves which feature a perfect balance of dispersion and nonlinearity and are known to be possible in the anomalous dispersion regime. Near the zero-dispersion wavelength (ZDW), the borderline between normal and anomalous dispersion, however, dispersive effects are relatively weak and it would seem most efficient to operate there, assuming that one can launch solitary wave pulses close to the ZDW. Accordingly, the question of existence of such pulses and their stability to frequency and amplitude modulations has been examined. While no single-hump solitary waves are possible near the ZDW, a countable infinity of symmetric, locally confined bound states having more than one hump have been found, both analytically in terms of a novel perturbation technique, and numerically by a shooting procedure. The stability of the two-hump bound state closest to the ZDW has also been examined. Linear stability analysis indicates the presence of a mild instability. Numerical simulations, however, reveal that, under certain conditions, nonlinearity has a stabilizing effect, permitting two-hump pulses to propagate for long distances without collapsing. Finally, the effect of higher-order dispersion on solitary pulses in the anomalous dispersion regime away from the ZDW has been studied. It has been demonstrated that these pulses emit radiation in general. This can be an important issue when dealing with pulses of relatively short duration, in the femto-second range.			
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The main objectives of this project are:

- (i) To examine the nature of solitary wave pulses close to the zero-dispersion wavelength (ZDW). This includes the question of existence of such pulses and their stability to frequency and amplitude perturbations.
- (ii) To explore the possibility of using these waves in soliton-based long-distance communication systems. This calls for a study of the robustness of such pulses in the presence of perturbations caused by attenuation, birefringence, the Raman effect, as well as non-uniformities along the fiber.

Based on the modified NLS equation that accounts for third-order dispersion, we have shown, both analytically and numerically, that there is a plethora of solitary waves near the zero-dispersion wavelength (ZDW) where second-order dispersion vanishes. These are multi-hump solitary wave pulses and occur as eigensolutions: fixing the carrier wavenumber determines the wave profile.

We have examined the stability of these multi-hump pulses, in particular the two-hump bound state for which third-order dispersion is most significant. Linear stability analysis indicates the presence of a mild instability with $O(10^{-2})$ growth rate. Numerical solutions of the modified NLS equation, however, reveal that, under certain conditions, nonlinearity has a stabilizing effect, permitting two-hump pulses to propagate for long distances without collapsing. Depending on the type of perturbation, a perturbed bound state evolves to a neighboring state with carrier frequency shifted either towards or away from the ZDW. The evolution of more general pulse profiles near the ZDW was also explored: based on numerical simulations, it would appear feasible to form a pulse resembling a two-hump bound state that may propagate for a considerable distance (several thousands of km), as long as the initial profile retains some features of a bound state.

In most recent work, we have also studied the effects of higher-order dispersion on NLS solitary wave pulses (in the anomalous dispersion regime away from the ZDW) of relatively short duration. It turns out that such pulses emit radiation which, however, cannot be described accurately by the NLS equation and its extensions. This radiation can be an important issue when dealing with pulses of relatively short duration, in the femto-second range.

The existence of solitary waves near the ZDW and the fact that these waves are, according to all indications, not unstable (contrary to opposite claims made in previous work) might prove of some technological significance in long-distance communications. Because second-order dispersion vanishes at the ZDW, the newly discovered solitary waves are of shorter duration than their NLS counterparts (with the same peak amplitude), and they could be used to increase the transmission bit rate. Moreover, understanding the radiation emitted by relatively short NLS solitary wave pulses in the anomalous dispersion regime should be beneficial in controlling this radiation and thereby reducing noise.

PERSONNEL SUPPORTED

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PUBLICATIONS

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